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WHAT IS CLAIMED IS:

1. A process for cross-linking sulfonyl groups of a sulfonated polymers wherein at least a fraction of the cross-linking bonds bear an ionic charge, the process comprising contacting the polymer with the cross-linking agent allowing the reaction between two sulfonyl groups from adjacent polymeric chains, to form the said cross-linking bonds.

2. Process according to claim 1 wherein the cross-linking bonds are of the type:

$P\text{-}SO_2\text{-}Y^-(M^+)\text{-}SO_2\text{-}P'$; or

$P\text{-}SO_2(M^+)Y^-SO_2\text{-}(Q\text{-}SO_2)_rY^-(M^+)SO_2\text{-}P'$

wherein

- P and P' are the same or different and are part of a polymeric chain;
- Y comprises N or CR wherein R comprises H, CN, F, SO_2R^3, $C_{1\text{-}20}$ alkyl substituted or unsubstituted; $C_{1\text{-}20}$ aryl substituted or unsubstituted; $C_{1\text{-}20}$ alkylene substituted or unsubstituted, wherein the substituent comprises one or more halogen, and wherein the chain comprises one or more substituent F, SO_2R, aza, oxa, thia ou dioxathia;
- R^3 comprises F, $C_{1\text{-}20}$ alkyl substituted or unsubstituted; $C_{1\text{-}20}$ aryl substituted or unsubstituted; $C_{1\text{-}20}$ alkylene substituted or unsubstituted, wherein the substituent comprises one or more halogens;
- M^+ comprises an inorganic or organic cation;
- Q comprises a divalent radical $C_{1\text{-}20}$ alkyl, $C_{1\text{-}20}$ oxaalkyl, $C_{1\text{-}20}$ azaalkyl, $C_{1\text{-}20}$ thiaalkyl, $C_{1\text{-}20}$ aryl or $C_{1\text{-}20}$ alkylaryl, each being optionally substituted by one or more halogens, and wherein the chain comprises one or more substituents oxa, aza or thia; and
- r is 0 or 1.

3. Process according to claim 2 wherein M^+ comprises the proton, a metal cation, an organometallic cation or an organic cation optionally substituted with one or more organic radicals comprising:

- a proton, an alkyl, an alkenyl, an oxaalkyl, an oxaalkenyl, an azaalkyl, an azaalkenyl, a thiaalkyl, a thiaalkenyl, a dialkylazo, a silaalkyl optionally hydrolysable, a silaalkenyl optionally hydrolysable, each being straight, branched or cyclic and comprising from 1 to 18 carbon atoms;

- a cyclic or heterocyclic aliphatic radical comprising from 4 to 26 carbon atoms optionally comprising at least one lateral chain comprising one or more heteroatoms such as nitrogen, oxygen or sulfur;

- an aryl, an arylalkyl, an alkylaryl and an alkenylaryl of from 5 to 26 carbon atoms optionally comprising one or more heteroatoms in the aromatic nucleus or in a substituent.

4. Process according the claim 3 wherein the metal comprises an alkaline metal, an alkaline-earth metal, a rare earth or a transition metal; the organic metallic cation comprises metallocenium, an arene-metallocenium, an alkylsilyl, an alkylgermanyl or an alkyltin, and the organic cation comprises $R"O^+$ (onium), $NR"^+$ (ammonium), $R"C(NHR")_2^+$ (amidinium), $C(NHR")_3^+$ (guanidinium), $C_5R"N^+$ (pyridinium), $C_3R"N_2^+$ (imidazolium), $C_2R"N_3^+$ (triazolium), $C_3R"N_2^+$ (imidazolinium), $SR"^+$ (sulfonium), $PR"^+$ (phosphonium), $IR"^+$ (iodonium), $(C_6R")_3C^+$ (carbonium), wherein R" is defined as an organic radical as defined above, and when an organic cation comprises at least two radicals R" different from H, these radicals can form together a cycle, aromatic or not, eventually containing the center bearing the cationic charge.

5. Process according to claim 2 wherein the divalent radical and the sulfonated polymer are partially or completely fluorinated.

6. Process according to claim 1, wherein a leaving group is linked to the sulfonyl groups before performing the cross-linking.

7. Process according to claim 6 wherein the leaving group comprises F, Cl, Br, an electrophilic heterocycle N-imidazolyl, N-triazolyl, R^2SO_3, R^2 being an organic radical optionally halogenated, the organic radical comprising:

- a proton, an alkyl, an alkenyl, an oxaalkyl, an oxaalkenyl, an azaalkyl, an azaalkenyl, a thiaalkyl, a thiaalkenyl, a dialkylazo, a silaalkyl optionally hydrolysable, a silaalkenyl optionally hydrolysable, each being straight, branched or cyclic and comprising from 1 to 18 carbon atoms;

- a cyclic or heterocyclic aliphatic radical comprising from 4 to 26 carbon atoms optionally comprising at least one lateral chain comprising one or more heteroatoms such as nitrogen, oxygen or sulfur;

- an aryl, an arylalkyl, an alkylaryl and an alkenylaryl of from 5 to 26 carbon atoms optionally comprising one or more heteroatoms in the aromatic nucleus or in a substituent.

8. Process according to claim 2 wherein the cross-linking agent comprises an organometallic comprising organo-lithium, organo-magnésium, magnesium or organo-aluminium, or a compound of general formula:

$(M^+)A_2Y^-$;

$(M^+)AY^-SO_2Y^-A(M^+)$;

$(M^+)AY^-SO_2QY^-A(M^+)$

wherein Y, Q and M are as defined above, and A comprises M, $Si(R')_3$, $Ge(R')_3$ or $Sn(R')_3$ wherein R' is C_{1-18} alkyle.

9. Process according to claim 8 wherein A comprises a trialkylsilyl group.

10. Process according to claim 8 wherein the cross-linking agent comprises Li_3N; C_3Al_4; $[(CH_3)_3Si]_2NLi$ (or Na or K); NH_3 + 3 DABCO; $CF_3SO_2C[(CH_3)_3Si][Li(TMEDA)]_2$; $(CH_3)_3CNH_2$ + 3 TEA; $NH_2SO_2NH_2$ + 4 TEA; $[[(CH_3)_3Si](Li)N]_2SO_2$; $[(TMEDA)(Mg)N]_2SO_2$; CH_3Li; $(CH_3)_3Al$; NH_2Li (or Na or K); $[[Si(CH_3)_3](Li)NSO_2]_2CF_2$; $[Li[Si(CH_3)_3]NSO_2CF_2]_2CF_2$; $[(Li)Si(CH_3)_3NSO_2CF_2]$; $[Li[Si(CH_3)_3]NSO_2CF_2CF_2]_2O$; SO_2Cl_2 + 3 DABCO; $SO_2(imidazole)_2$; $[FSO_2CF_2]_2$ + 3 TEA; $(ClSO_2CF_2)CF_2$ + 3 DABCO and $(FSO_2CF_2CF_1)_2O$ + 3 DABCO.

11. Process according to claim 1 wherein the non cross-linked polymer is molded before being cross-linked.

12. Process according to claim 1 wherein the non cross-linked polymer is mechanically blended with the cross-linking agent, pressed and heated.

13. Process according to claim 1 wherein the non cross-linked polymer is molded and contacted with a solution of the cross-linking agent in an inert solvent.

14. Process according to claim 13 wherein the cross-linking density is controlled by the time of immersion in the solvent, the temperature of the solvent, or the cross-linking agent concentration in the solvent.

15. Process according to claim 13 wherein the solvent comprises aromatic hydrocarbons, hydrocarbons and aliphatic ethers partially or completely halogenated, THF, alkylethers of mono-, di- tri- and tetraethylene glycols (glymes), tertiary alkylamides including DMF, N-methylpyrrolidone, tetramethylurea and its cycling analogues, N-alkylimidazoles, tetraalkylsulfamides, and mixture thereof..

16. Process according to claim 2 wherein the non cross-linked polymer is molded and contacted with the cross-linking agent and a non cross-linking ionogene agent to form end groups $-SO_3^-(M^+)$, or $-[SO_2YSO_2R]^-(M^+)$, R being an organic radical as defined above, preferably halogenated, and particularly perfluorinated.

17. Process according to claim 16 wherein the non cross-linked polymer is molded and contacted sequentially or simultaneously with the cross-linking agent and the non cross-linking ionogene agent.

18. Process according to claim 16 wherein the non cross-linking ionogene agent comprises $(CH_3)_3SiO^-(M^+)$ or $[(CH_3)_3SiNSO_2CR_F]^-(M^+)$ wherein M^+ is as defined above and R_F is an alkyl, oxaalkyl, azaalkyl or thiaalkyl radical essentially perfluorinated and comprising from 1 to 12 carbon atoms.

19. Process according to claim 1 wherein a reinforcing agent is added to the polymer before the cross-linking.

20. An electrochemical cell wherein a membrane comprising a cross-linked polymer according to claim 1 is used as a solid electrolyte.

21. A cell according to claim 20 comprising a fuel cell, a water electrolyser, an alkali-chloride cell, an acid or salts electrochemical cell, or an ozone-producing cell.

22. A cell according to claim 21 forming an element of a fuel cell wherein M^+ is a hydrated proton and the positive electrode comprises an oxygen reducing catalyst.

23. A sulfonated polymer comprising in whole or in part cross-linked sulfonyl groups, and wherein at least a fraction of the cross-linking bonds bear an ionic charge.

24. A polymer according to claim 23 wherein the cross-linking bonds are of the type:

$P\text{-}SO_2\text{-}Y^-(M^+)\text{-}SO_2\text{-}P'$

$P\text{-}SO_2(M^+)Y^-SO_2\text{-}(Q\text{-}SO_2)_r Y^-(M^+)SO_2\text{-}P'$

wherein

- P, P', Y, Q, M^+ and r are as defined in claim 2.

25. A polymer according to claim 24 wherein M^+ comprises the proton, a metal cation, an organometallic cation or an organic cation optionally substituted by one or more organic radical comprising:

- a proton, an alkyl, an alkenyl, an oxaalkyl, an oxaalkenyl, an azaalkyl, an azaalkenyl, a thiaalkyl, a thiaalkenyl, a dialkylazo, a silaalkyl optionally hydrolysable, a silaalkenyl optionally hydrolysable, each being straight, branched or cyclic and comprising from 1 to 18 carbon atoms;

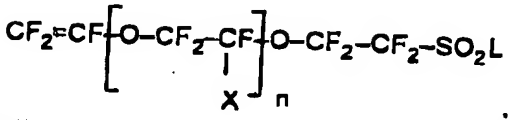
- a cyclic or heterocyclic aliphatic radical comprising from 4 to 26 carbon atoms optionally comprising at least one lateral chain comprising one or more heteroatoms such as nitrogen, oxygen or sulfur;

- an aryl, an arylalkyl, an alkylaryl and an alkenylaryl of from 5 to 26 carbon atoms optionally comprising one or more heteroatoms in the aromatic nucleus or in a substituent.

26. A polymer according to claim 25 wherein the metal comprises an alkaline metal, an alkaline-earth metal, a rare earth or a transition metal; the organic metallic cation comprises metallocenium, an arene-metallocenium, an alkylsilyl, an alkylgermanyl or an alkyltin, and the organic cation comprises $R''O^+$ (onium), NR''^+ (ammonium), $R''C(NHR'')_2^+$ (amidinium), $C(NHR'')_3^+$ (guanidinium), $C_5R''N^+$ (pyridinium), $C_3R''N_2^+$ (imidazolium), $C_2R''N_3^+$ (triazolium), $C_3R''N_2^+$ (imidazolinium), SR''^+ (sulfonium), PR''^+ (phosphonium), IR''^+ (iodonium), $(C_6R'')_3C^+$ (carbonium), wherein R'' is defined as an organic radical as defined above, and when an organic cation comprises at least two radicals R'' different from H, these radicals can form together a cycle, aromatic or not, eventually containing the center bearing the cationic charge.

27. A polymer according to claim 24 wherein the divalent radical and the sulfonated polymer are partially or completely fluorinated.

28. A polymer according to claim 23 derived from at least of the following monomers:



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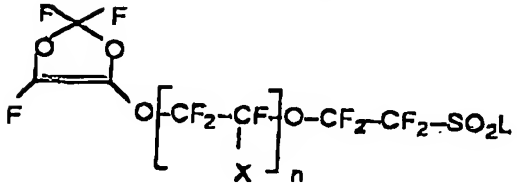

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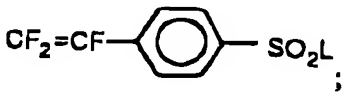

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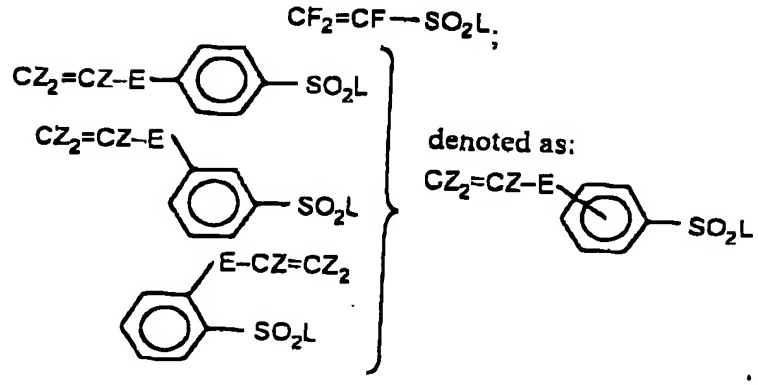

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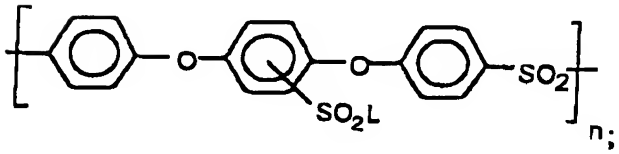
or:



wherein

- X is F, Cl or CF_3;
- n varies between 0 and 10 inclusively;
- E is absent, O, S, SO_2;
- Z is H or F; and
- L is a leaving group.

29. A polymer according to claim 23 further comprising a reinforcing agent.

30. The use of a cross-linked polymer according to claim 23 in an alkali-chloride electrolysis process, as a separator in an electrochemical preparation of organic and inorganic compounds, as a separator between an aqueous and organic phase, or as a catalyst for Diels-Alder additions, Friedel-Craft reactions, aldol condensation, cationic polymerisation, esterifications and acetal formations.